Challenges faced when energy meets water: water implications of power generation in the northern regions of China

Topic: Input-Output economics and industrial ecology - LCA analysis 1
Author: Xin Li
Co-Authors: Klaus Hubacek, Kuishuang Feng, Yim Ling Siu

Most energy-water nexus studies focus on either the amount of water (in terms of withdrawal or consumption, or both) needed during the life-cycle phases of power generation. Limited studies have looked at water quantity-quality impacts of electricity production and hence, there is a need to fill the knowledge gap.

Using the integrated hybrid life cycle analysis, this study examines the life cycle impacts on water consumption and water quality of three electricity generation systems (coal power, wind power and solar power) in Inner Mongolia, China. The reasons of choosing Inner Mongolia are 1) Inner Mongolia is the second largest coal producer in China. China has initiated the reinforcement of electricity transmission system, which aims to increase the ratio of power transmission to coal transportation from 1:20 in 2005 to 1:4 in 2020. The changes in ratio could have significant implications on the water availability and water quality in Inner Mongolia. 2) Inner Mongolia has the largest potential in wind and solar energy. Inner Mongolia has the largest wind power generation capacity in China and the 2nd largest solar power potential. Since the Chinese government has been affirmative in promoting renewable energy sources, the contribution of renewable energy to total energy supply will be significant in the future. Conclusions derived from previous energy-water nexus studies have shown that wind power and solar power could be water-saving solutions. However, the extents to which these renewable energy technologies contribute to water quality changes are still unknown. 3) Inner Mongolia has been suffering from severe water shortages. Since power generation is the second largest water consumer, it is necessary to assess the impacts of power generation on water resources. Looking at the entire nation, a study could derive a general conclusion of the water impacts of selected power generation technology. Given the chosen geographical coverage, however, such study is not able to reflect the situation at regional level. In China, the northern regions are generally short of water resources, whilst the southern China is abundant in water supply relatively. Inner Mongolia, which locates in the northern China, has been suffering from severe water shortages. According to China Environment Statistical Yearbook (2009), 18 per cent of people in Inner Mongolia do not have access to freshwater, which is the higher than any other regions in China. Total water shortage would increase from 1,000 million cubic meters in 2011 to 3,000 million cubic meters in 2020. Inner Mongolia could represent the current power generation mix in northern China, which has more than 95% of electricity generated by coal.

The most recent Inner Mongolia input-output table for the year 2007 is applied. The process-based life cycle data are from Eco-invent Database, which we extract a 300MW coal power system, an 800kW wind power and solar PV. The sector classification of Inner Mongolia is identical to the national input-output table, which has 135 economic sectors. Sectoral water data, including freshwater consumption, wastewater discharge and COD emissions data are from China Statistical Yearbook and Inner Mongolia Statistical Yearbook, respectively. The outcome of this research would help to improve the understanding of the power generation system in China from a water perspective. The results generated would provide quantitative evidences to the regional power system planning by taking sustainability indicators into account.